

Economic Analysis on Employee Invention System from the Viewpoint of R&D Incentive and Welfare Loss Arising from Lawsuit against for Remuneration for Invention (*)

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This paper studies the effect of employee invention systems on economic performance by economic model (especially, property right theory). Property rights theory discusses how property rights including patents affect incentive (e.g. incentive for R&D). The purpose of employee invention systems is to affect distribution of profit from invention between employers and employees and to promote R&D activity. We present a model that suggests that effects of employee inventions on distribution of profit from invention and incentive may differ depending on the difficulty in prediction of profit from invention and the size of loss caused by lawsuits. Furthermore, we study cases for an appropriate amount of remuneration and study how an appropriate amount of remuneration is calculated. We also show that the effect of employee invention systems may differ among industries by using the results from a theoretical analysis and case studies. Finally, we discuss what employee invention systems should be like.

I Introduction

Invention is essential for technological development and for economic growth. Today, most R&D activity is done by employees who belong to a firm and conduct R&D activity as their task. Inventions made by such employees are called employee inventions. The Japanese employee invention system allows the rights to patents, etc. to be transferred from an employee to the employer when an invention is created. However, an employer must pay an appropriate amount of remuneration when the right is transferred. Many lawsuits occurred over the appropriate amount of remuneration in Japan and high amount of an appropriate amount of remuneration was determined in some lawsuits. For example, in the data set used for the case study in this paper, which consists of 105 cases related to employee invention (related to Patent Act Article 35), appropriate amounts of remunerations are determined in 33 cases and more than ten million yen in seven of those and more than one hundred million yen in two of those are determined. Many firms insisted that the Japanese employee invention system causes a management risk. In Heisei 16 and Heisei 27, laws concerning the Japanese employee invention system have been amended.

This paper studies how employee invention systems, especially requirement of an appropriate amount of remuneration, affects compensation system offered by employers by using economic theory. The appropriate amount of remuneration for employees is the monopolistic profit for an employer multiplied by the employees' ratio of contribution. If more than one

employee contributes to the invention, the appropriate amount of remuneration for each employee is the appropriate amount of remuneration for employees multiplied by the ratio of each employee's contribution among all employees. A monopolistic profit obtained from an invention consists of two monopolistic profits. One is a license fee, which an employer obtains by allowing a third party to implement an invention. The other is self-implement profit that is obtained because an employer monopolistically implemented the invention.

One difficulty in terms of the appropriate amount of remuneration is to predict and to measure it objectively. This paper studies Japanese employee invention system from the view point that an appropriate payment based on self-implementation profit is difficult and generates uncertainty due to the following reason. To calculate self-implementation profit, we must know how large profit is expected compared to the profit which would be obtained if the employer did not exclude third parties to implement an invention. However, it is impossible to know precisely how much profit would be obtained if the employer did not exclude them. Even if an employer estimates the self-implementation profit in some way and she pays an appropriate amount of remuneration based on the estimated value, the estimated value by the employer may differ from that by the court. Hence, there is a risk of lawsuits. On the other hand, the license fee is more objective because it is known through license contracts. Thus, payment based on a license fee is easier compared to the case of self-implementation profit.

We study the employee invention system by presenting a model adopting an approach recently

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developed by a new property right theory (Hart, 2009; Muramoto, 2013). Especially focusing on the difficulty of the payment scheme based on self-implement profit, we examine how a firm who faces with the uncertainty of an appropriate amount of remuneration designs a compensation scheme for employee inventions. Furthermore, using an online legal service, we study cases of lawsuits for an appropriate amount of remuneration. We study how an appropriate amount of remuneration is determined in cases and discuss the uncertainty in an appropriate amount of remuneration that firms face. Finally, based on the results in the case study, we discuss the possibility that the uncertainty in an appropriate amount of remuneration that a firm faces with differs among industries. Using the results of theoretical analysis, we predict how compensation schemes for employee invention differs among industries.

Our study notices the difficulty of an appropriate reward based on self-implement benefit. Among economic theories, incomplete contract theory and property rights theory generally discuss the situations where trading parties cannot sign a contract that appropriately specifies the future contingencies. Especially, traditional property right theory (Grossman and Hart 1986; Hart and Moore 1990; Aghion and Tirol 1994) mainly focuses on the under-investment problem: participants in a trade do not make effort or investment sufficiently because they cannot obtain a sufficient amount of return for the effort and investments. In such situations, when a participant's investment or effort is very important, the participant's investment should be enhanced by strengthening his bargaining position depending on the level of importance of his investment or effort compared to others and how much his investment of effort is responsive to a financial reward for him. In the case of an employee invention, how much an employee's bargaining position should be protected depends on how much his effort is important for invention compared to the employer's investment and how much his effort increases when his reward increases. If the employee's effort is very important and his effort is very responsive to his reward, the employee's bargaining position should be strengthened by a high amount of appropriate remuneration.

As mentioned above, property rights theory mainly focuses on the incentive problem. However, they usually ignore economic loss caused by lawsuits and uncertainty in lawsuits and focuses on the problem of incentive. However, it is not enough to consider only the incentive problem when an employee invention system is studied, due to the following two reasons. One reason is that the obligation to pay an appropriate amount of remuneration affects economic loss caused by lawsuits. Thus, to discuss the desirability of the employee invention system, we must consider the economic loss. The other reason is that

economic loss by lawsuits and uncertainty in an appropriate amount of remuneration may affect incentives. For example, if economic loss caused by lawsuits is very large, employers may change the reward for invention to reduce the probability of lawsuits. This change may affect employees' incentives. To consider these problems concerning economic loss by lawsuits and uncertainty, this paper adopts the approach of a new property right theory (Hart 2009; Muramoto 2013).

The rest of this paper is organized as follows. Section II presents a theoretical model and analyses how uncertainty in an appropriate amount of remuneration and inefficiency arising from lawsuits affects compensation schemes for employee inventions offered by employers. Section III studies cases in which the appropriate amount of remuneration was certified by the court. Through these case studies, we clarify how the appropriate amount of remuneration is calculated in the court and discuss uncertainty in the appropriate amount of remuneration. Section IV combines the results in theoretical analysis and case studies and presents a new prediction. Section V concludes with remarks on the desirable employee invention system.

II Theoretical Analysis

1 The Model

This section presents a model that analyzes how an employee invention system affects the reward system that an employer offers to an employee. In our model, the right to patent, etc. is transferred to the employer when the employee makes an invention. At that time, it is mandated that the employer must pay an appropriate amount of remuneration for the invention. If the reward for the employee is lower than the appropriate amount of remuneration and the employee sues for it, the employer must pay the shortage. We assume that a lawsuit generates an economic inefficiency (e.g. a lawsuit may delay production).

The appropriate amount of remuneration is computed as the contribution ratio of an employee times the monopolistic profit by the invention. Although more than one employee often contributes to an invention in the real world, we assume that only one employee contributes to the invention in our model, for simplicity. The appropriate amount of remuneration is the sum of two kinds of profits. One is a license fee. The employer obtains a license fee by allowing a third party to implement an invention. The other is self-implementation profit. The employer obtains such profit by implementing the invention exclusively, i.e. he implements the invention without allowing others to implement it.

Between these two kinds of profits, self-implementing profit seems to be more difficult to measure objectively and to be redistributed to an

employee as an appropriate amount of remuneration. We model the situation where the employer does not allow third parties to implement the patented invention and implement it exclusively and so only self-implement profit rather than a license fee is realized. We also assume that there is no uncertainty in the contribution ratio of an employee determined in a lawsuit, although such uncertainty exists in reality, as we mention in the case studies.

The timing of the model is as follows. At period 0, an employer offers an amount of reward, b , for an invention. At that time, she does not know how much self-implementation profit the invention will earn. We assume that the amount of reward for an invention cannot be conditional on the amount of self-implementation profit and it is a constant value. Hereafter, we denote the profit of self-implementation profit by π . At period 1, an invention is realized and commercialized and self-implement profit comes to be calculated. For simplicity, we assume that a low amount of self-implement profit $\pi = \pi^L$ is realized with probability $1 - p$ and a high amount of self-implement profit $\pi = \pi^H$ is realized with probability p . We assume that there is no difference in the calculations among the employer, employee, and court.

The employee decides whether to file a lawsuit or not. If the employee does not file a lawsuit, the amount of reward offered by the employer is paid to the employee. Let u_P and u_E be the ex post payoffs for the employer and employee, respectively. Then,

$$\begin{aligned} u_P &= \pi - b, \\ u_E &= b. \end{aligned}$$

If the employee decides to file a lawsuit, a lawsuit occurs. Then,

$$\begin{aligned} u_P &= (1 - \beta)\pi - \lambda, \\ u_E &= \beta\pi, \end{aligned}$$

where β is the employee's contribution ratio to the invention (CRI, hereafter) and λ is the amount of inefficiency arising from lawsuits. After the lawsuit, the reward for the employee is changed to the appropriate remuneration for the invention $\beta\pi$. The employer receives π , pays the appropriate amount of remuneration, and suffers loss caused by lawsuit.

2 Result

The next corollary follows the result of our model (see the analysis and Proposition 1 in II.3 in the full paper version.)

Corollary 1: When the loss from lawsuits exceeds the threshold level L^* , the employer increases the award for invention to avoid lawsuits and so the employee's expected payoff increases. The increases in the amount of reward become greater as the extent of the profits' variation $\pi^H - \pi^L$ increases. Conversely, the employer's expected payoff weakly decreases with the loss from lawsuits increases.

Figure 1 illustrates the relationship between the expected profits for the employees. The vertical line indicates the expected profits and the horizontal line indicates the amount of loss caused by a lawsuit.

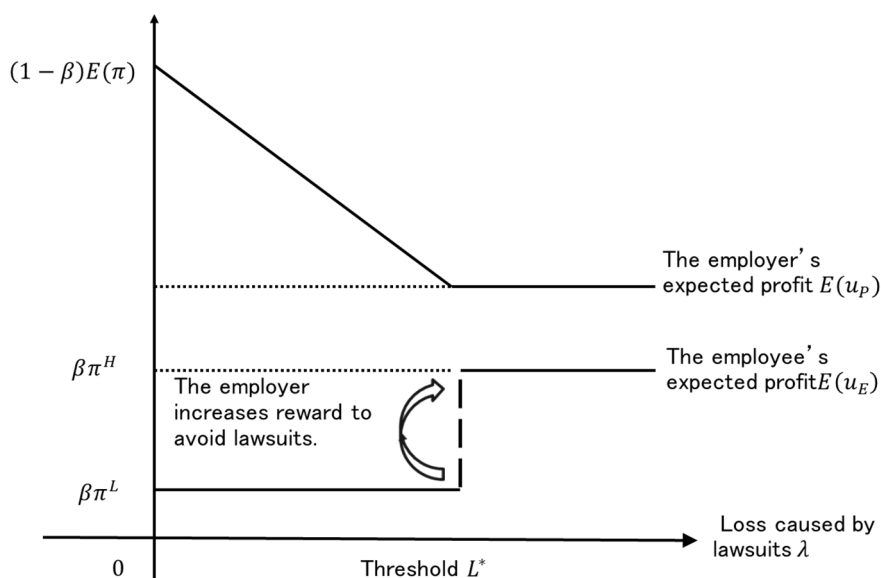


Figure 1

III Case Study

In Section II, we have presented a theoretical model adopting an approach recently developed by the new property right theory and discussed how a firm, who faces with uncertainty in an appropriate amount of remuneration, offers an award scheme for employee invention. This section studies the cases for an appropriate amount of remuneration and examines uncertainty in appropriate amount of remuneration firms faces with by investigating how an appropriate amount of remuneration is calculated in lawsuits.

We study the 105 cases of lawsuits from April 2005 to July 2015 in Japan concerning Article 35 of the Patent Act by using an online legal service, Westlaw Japan, 33 of which determine appropriate amounts of remuneration.

We found that there are four characteristics in calculation of an appropriate amount of remuneration.

Feature 1: When the profit that an employer earned from the invention is sufficiently high, the employee's contribution ratio tends to be determined to be low.

Figure 2 shows that the employer's profit from invention and the employee's contribution ratio that are determined by the court are negatively correlated.

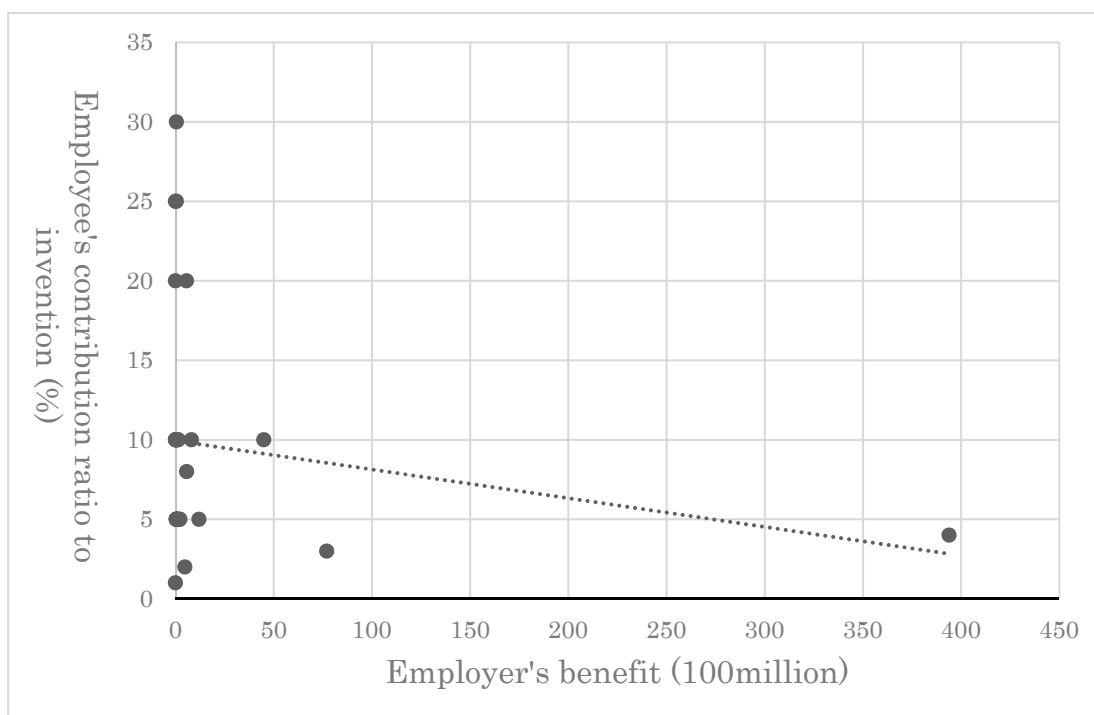


Figure 2

Furthermore, we found the description that supports Feature 1 in the judgment of cases¹.

The appropriate amount of remuneration is calculated as the profit from invention for the employer multiplied by the employee's contribution ratio. Thus,

Feature 1 weakens the effect on the appropriate amount of remuneration caused by the variance of the profit from invention for the employer. However, as Feature 2 shows, Feature 1 is not so strong that it completely cancels out the effect caused by the variance of the profit from

invention for the employer.

Feature 2: The higher the profit from invention for the employer is, the higher the appropriate amount of remuneration is calculated.

We can confirm Feature 2 by Figure 3, which illustrates the relation between employers' benefit and amount of appropriate remuneration.

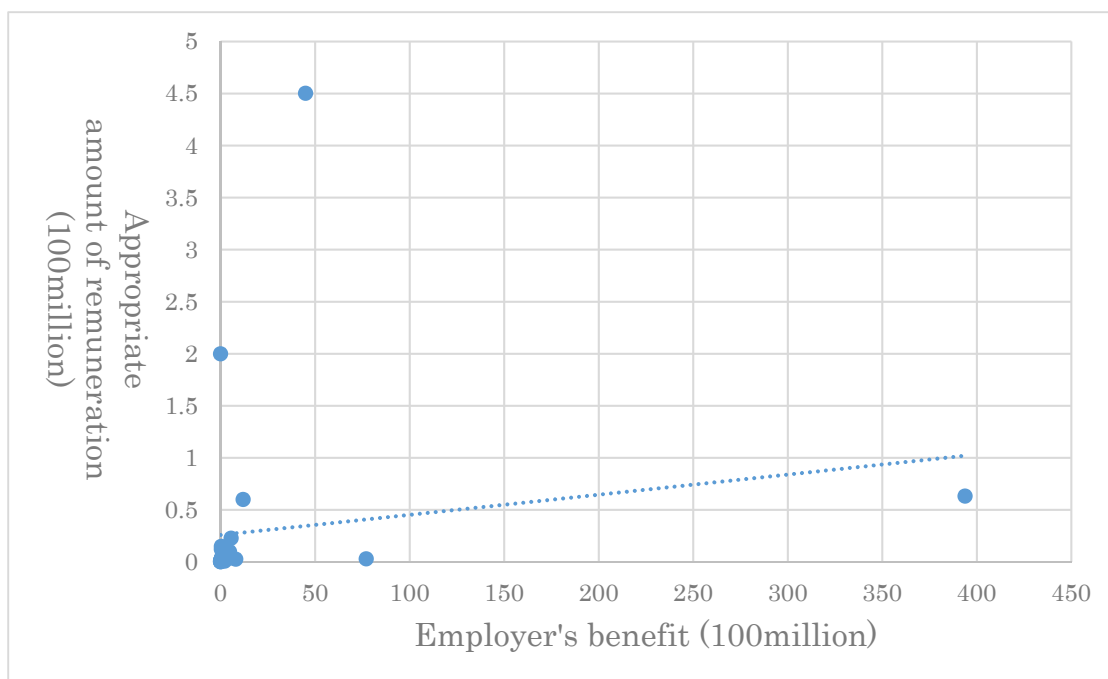


Figure 3

Feature 3: When multiple patents are comprehensively licensed, the contribution ratio of each patent to the comprehensive license is determined.²

As mentioned above, in principle, it is easy to measure a license fee objectively and pay a reward according to the amount of license fee. However, when the patent of a particular invention and other patents are comprehensively licensed and a license fee is paid for all of the patents, there is a difficulty to decide the fraction each patent contributes to the whole license fee.

Feature 4: There have been many lawsuits concerning self-implementation profit.

In Chapter II, we modeled the situation in which lawsuits may occur due to the difficulty in appropriate payment according to self-implementation profit. In fact, 84 percent of the lawsuits studied in this Section concern self-implementation profits. Furthermore, for 78 percent of the whole lawsuits, courts determine the self-implementation profit when the appropriate amount of remuneration is calculated.

IV Analysis based on the results of theoretical analysis and case study

This section studies whether the employee invention system may have different effect depending on the industry that the invented patent belongs to and if so, how the effect differs. Based on the results of theoretical analysis and case studies, we have the following two predictions.

Prediction 1: If an invented technology earns a huge amount of profit with very small probability and is commercialized without combining other patents, uncertainty in the appropriate amount of remuneration is high. As a result, employees obtain high reward and their incentive increases. On the other hand, employers' profit and their incentive to invest decrease.

Prediction 2: If an invented technology earns a medium amount of profit with not so small probability and is commercialized combined with many other patents, uncertainty in the appropriate amount of remuneration is low. As a result, compared to the case mentioned in Prediction 1, employees obtain low incentive and their incentive is low. On the other hand, employers' profit and their incentive to invest are high.

V Conclusion

We have studied the employee invention system by adopting the new property rights approach to model the uncertainty in appropriate remuneration and the loss caused by lawsuits. Our results are as follows. Firstly, theoretical analysis showed the following three. One is that many lawsuits occur due to the difficulty to measure self-implement profit and to pay an appropriate amount of remuneration according to it. Second, an employer pays an amount of reward that exceeds the fraction of employees' contribution to the invention of the profit when the loss caused by lawsuits is high. Even when the employee invention system mandates that employers pay a reward equal to the fraction of employees' contribution of the profit from invention, the employers tend to pay more to avoid costly lawsuits. Third, strength of this tendency depends on the nature of the invention (e.g. the industry that an invention belongs to).

In the case studies, we have founded the four characteristics in calculation of an appropriate amount of remuneration. Finally, in the analysis based on the results of theoretical analysis and case study, we have presented prediction that how the employee invention system affects award schemes for employee invention may differ depending on the nature of a patented invention, especially the industry the invention belongs to.

Among these results, the theoretical results have the following implication on the employee invention system: the appropriate amount of remuneration should be independent of or less depend on self-implementation profit due to the following two reasons. First, we can decrease the probability of lawsuits by weakening the dependence on self-implementation profit. As mentioned above, dependence of an appropriate amount of remuneration on self-implementation profit generates uncertainty in the appropriate amount of remuneration and induces lawsuits. If the appropriate amount of remuneration is independent or less dependent of self-implement profit, the uncertainty and the probability of lawsuits decrease. Second, the reward for invention has upward bias: employers tends to pay more than the fraction of contribution of employees. By reducing the appropriate remunerate amount of remuneration by self-implementation profit, the upward bias is mitigated.

It is worth noting that our analysis is limited due to the following reasons and hence our results should be regarded as tentative. First, the approach of the new property right theory which we adopt in this paper is very new and has not been sufficiently tested. Especially, the results on the theoretical analysis depend on assumptions we made (see II .2. (3) in the full paper version of this summary for detail). For example, our basic model assumes that only an employer suffers the loss caused by lawsuits. If we reassume that both employer and

employee suffer the loss caused by lawsuits, the results may change. Furthermore, only in 32 cases of our data set, appropriate remuneration is determined. Thus, the sample size is very small and hence reliability of the case study results is not high. The same is the case with the analysis in Section IV. These points should be examined in future research.

References

- Aghion, P., and Tirole, J. (1994) "The Management of Innovation," *Quarterly Journal of Economics*, 109: 1185-1207.
- Grossman, S., and Hart, O. (1986) "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy* 94: 691-719.
- Hart, O. (2009) "Hold-up, Asset Ownership, and Reference Points." *Quarterly Journal of Economics* 124(1): 267-300.
- Hart, O., and Moore, J. (1990) "Property Rights and the Nature of the Firm." *Journal of Political Economy* 98: 1119-1158.
- Muramoto, A. (2013) "Strategic Determination of Renegotiation Costs" KIER Working Papers No 877.

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- ¹ Tokyo District Court Judgment 2006 (Hanji)1948. See the full paper version of this summarized report for detail.
- ² Tokyo District Court 2007 (Hanji) 1971.